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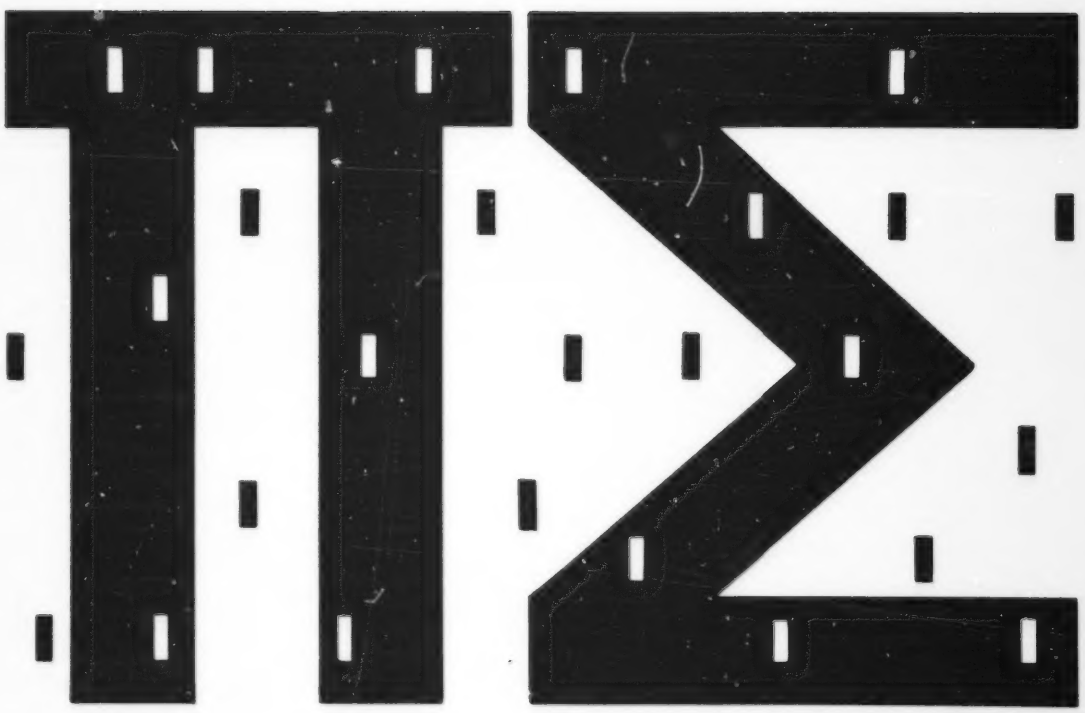

A SCENARIO FOR OFFSHORE HYDROCARBON ACTIVITY IN THE QUEEN CHARLOTTE ISLANDS AREA
CASD PROJECT U690

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1. Summary

To assess the environmental impact of hydrocarbon activity in the Queen Charlotte Islands (QCI) area*, it is important that a likely scenario for possible levels of hydrocarbon exploration and production be developed. In this paper estimates for a possible scenario are developed based on the average of six U.S. Department of Interior estimates of California and Alaska hydrocarbon activity.

By averaging data on the six west coast areas, it is concluded that if oil is discovered in the QCI area, there eventually could be 274 exploratory and delineation wells and 1,022 production and development wells which would produce some 1.94 billion barrels of oil and 5.43 trillion cubic feet of gas (Table 1). In addition, through inspection of the individual lease sales on which these averages are based, the number of exploratory and development wells could be between 30% and 500% of the average estimates.

To assess the usefulness of these average figures, they are compared to 1983 Energy, Mines and Resources (EMR) production estimates for the QCI area and to the present number of wells in other Canadian offshore areas. The EMR production estimates are lower than those derived in this paper; the number of exploratory wells to date in other offshore regions in Canada are of the same order of magnitude as the 274 exploratory wells estimated herein.

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*Note: Throughout this report the term 'QCI area' is used to refer to the offshore areas in Dixon Entrance, Hecate Strait, and Queen Charlotte Sound held under exploration agreements by Petro-Canada and Chevron. (See Figure 1).

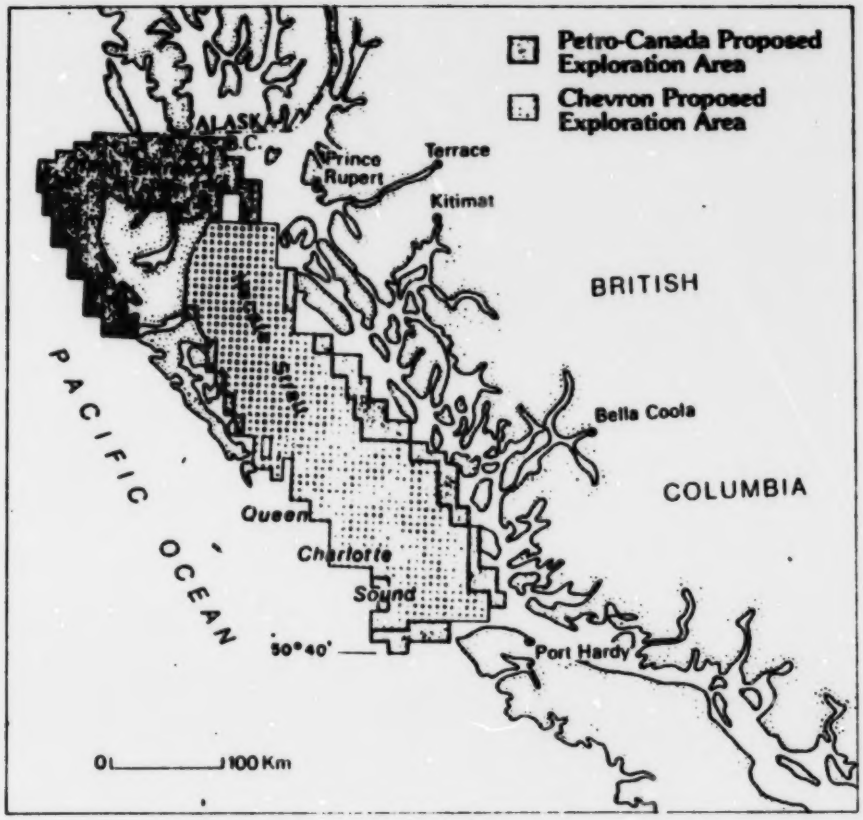

Figure 1
Proposed Exploration Areas

The shaded portions in the above map are referred to in this report as "the QCI area", i.e., Petro-Canada's and Chevron's proposed exploration areas in offshore British Columbia north of 50°40'.

Table 1.

A Scenario for Hydrocarbon
Exploration, Development and Production
in the QCI Area

Estimated Total Production of Oil (billion bbl)	1.94
Estimated Total Production of Gas (trillion cf)	5.43
Maximum Daily Oil Production (thousand bbl/day)	819
Maximum Daily Gas Production (million cf)	1,355
Number of Exploratory Rigs	28
Number of Exploratory and Delineation Wells	274
Exploratory Rig Structure-Years	93.1
Number of Development and Production Wells	1,022
Number of Production Platforms	37
Production Platform Structure-Years	919.8

2. U.S. Based Estimate

An analysis of U.S. federal government estimates for U.S. west coast offshore lease areas indicates that:

1. The average of the expected magnitude of production is .331 billion bbl of oil/million hectares leased, and .926 trillion cf of gas/million hectares leased.

2. The average of the expected magnitude of maximum daily oil production is about 0.042% of total expected production.

3. The average of the expected magnitude of maximum daily gas production is 0.025% of total expected production.

4. An average of 46.7 exploratory and delineation wells are drilled per million hectares leased.

5. There are 3.3 structure-years per exploratory or delineation rig.

6. There is an average of 3.7 development or production wells for each exploratory or delineation well.

7. On average there are 27.6 wells/production platform.

Chevron has leased 3.5 million hectares and Petro-Canada 2.4 million hectares in the QCI area (See Table 2).

As these areas are typified by tertiary sediments similar to those found offshore in Alaska and California, U.S. Dept. of Interior estimates of their west coast development potential were used to develop estimates for the QCI area. The U.S. figures were obtained from OCS sale nos. 73 (Central California), 70 (St. George Basin, Alaska), 88 (Cook Inlet and Gulf of Alaska), 57 (Norton Sound, Alaska) and Southern California (Table 2). To compare U.S. and Canadian lease areas, U.S. lease areas were defined as acres (hectares) offered while Canadian lease areas were defined as acres (hectares) leased*.

These estimates of production describe the oil or gas that would be produced over the proposed project's lifetime. This is a time period which may last from 15 to 40 years, depending on the oil or gas field.

The total QCI area hydrocarbon production estimates in Table 2 were derived from the U.S. figures on a per hectare basis. For example, as the average of the expected magnitude of total oil production per million hectares leased is .331 = (4.35 B bbl/13.1x10^6 ha) billion barrels, it was estimated that the total production from the Chevron lease area would be 1.16 = (.331 B bbl x 3.5 x 10^6 ha) billion barrels.

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*In the U.S., not all the acreage offered is taken up in leases. In Canada, the Canada Lands Act provides for exploratory agreements which enable companies to initially take up large areas for examination and then to reduce their holdings to the more promising areas as the exploratory work proceeds.

Table 2

U.S. Based Estimates of Potential QCI Hydrocarbon Activity

Area	Acres ($X10^6$)+	Ha ($X10^6$)+	Est. Total Prod. of Oil B bbl	Est. Total Prod. of Gas Tcf	No. Expl. & Del. Wells	No. Expl. & Del. Rigs	Rig-Yrs.	No. Dev. & Prod. Wells	No. Dev. & Prod. Platforms	Plat.-Yrs.	Max. Daily Gas Prod. MMcf	Max. Daily Oil Prod. Mbbl.
U.S.												
No. 73 Central Cal.[1]	2.01	0.81	0.97	0.95	120	-	-	800	30	677	242	248
No. 70 St. George Basin[2]	2.69	1.1	1.12	3.66	55	5	12	251	11	428	701	663
Southern Cal.[3]	11.6	4.7	1.13	2.01	340	-	-	950	27	476	788	501
No. 88 Cook Inlet[4]	4.5	1.8	0.12	0.68	21	-	-	22	2	57	177*	98
No. 88 Gulf of Alaska[4]	9.2	3.7	0.53	2.85	32	-	-	94	4	116	741*	122
No.57 Norton Sound[5]	2.44	0.99	0.48	2.01	45	5	21	172	9	307	389	274
Total	32.4	13.1	4.35	12.16	613	10	33	2,289	83	2,061	3,038	1,836
QCI												
Chevron	8.6	3.5	1.16	3.24	163	17	56	610	22	549	810	489
Petro-Can.	5.8	2.4	0.78	2.18	110	11	38	411	15	370	546	330
Total	14.5	5.9	1.94	5.43	274	28	93	1,022	37	920	1,355	819

Underlined figures are derived from U.S. figures

1. Data obtained from "Final Environmental Impact Statement OCS Sale No. 73" - Offshore Central California - U.S. Dept. of Interior - MMS - June 1983
2. Data obtained from "Final Environmental Impact Statement OCS Sale No. 70" - St. George Basin-Alaska OCS - Dept. of Interior - MMS - August 1982
3. Data obtained from "Final Environmental Impact Statement, Proposed Southern California Lease Offering" - U.S. Dept. of the Interior - MMS - April 1984
4. Data obtained from "Final Environmental Impact Statement, Proposed Gulf of Alaska/Cook Inlet Lease Sale 88" - U.S. Dept. of the Interior - MMS - July 1984
5. Data obtained from "Draft EnvironmentalImpact Statement, Proposed OCS Oil and Gas Lease Sale - Norton Sound" - U.S. Dept. of Interior - BLM - June 1981.

*inferred estimate - no figure given in EIS
+to make U.S. and QCI figures comparable, U.S. acreage = acres offered, while QCI acreage = acres leased.

MMcf - million cu. ft.
Tcf - trillion cu. ft.
Mbbl - thousand barrels
Bbbl - billion barrels

These calculations showed that the smallest individual lease sale would be 70% below the average scenario estimate and the highest individual lease sale scenario over five times the average scenario estimate.

The expected total number of exploratory wells in the QCI area was derived by taking the U.S. estimates of the number of exploratory wells per hectare leased and adjusting it for the size of the QCI hectarage. Thus, using the U.S. data in Table 2* it can be seen that the average number of exploratory wells per million hectares is 46.7 = (613 wells/13.1 x 10^6 ha). For the Chevron QCI lease area the number of exploratory wells would be 163 = (3.5 x 10^6 ha x 46.7 wells/10^6 ha).

From the U.S. data it can be seen that an average of 3.7 = (2,289 prod. wells/613 expl. wells) development and production wells are drilled per exploratory or delineation well. The estimate of QCI development and production wells was obtained by multiplying the number of exploratory and delineation wells by this ratio; e.g., for Petro-Canada (110 expl. & del. wells x 3.7 prod. wells/expl. & del. well) = 411 exploration and delineation wells.

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*Calculations made for this table involved the use of more significant digits than those actually shown. For this reason, sums or products may appear larger or smaller than the simple sum or product of their parts. The numbers shown have been rounded off for the sake of clarity; those used in calculations were not rounded off for the sake of accuracy. Calculations were, of course, limited by the estimate with the fewest number of significant digits.

Similarly the U.S.-derived estimate of 27.6 = (2,289 development and production wells/83 development and production platforms) for the average expected number of production wells per platform was used to derive the estimates of the expected number of platforms in the QCI area. Clearly the number of platforms depends on the size of the reservoirs found, but in the absence of any more precise, publicly available information, these rough estimates appear appropriate.

Again, using U.S. data it can be seen that the expected maximum daily output of oil is 0.042% = (1.836 mm bbl/day/4.35 B bbl) of expected total production and that expected maximum daily output of gas is 0.025% = (3.038 Bcf/day/12.126 Tcf) of expected total production. When these numbers are applied to the QCI area it is estimated that the maximum daily oil production would be 819 thousand barrels per day and maximum daily gas production would be 1,355 million cubic feet.

3. A Comparison With EMR/Canada Based Estimates

There are two ways of providing a better appreciation for the accuracy of these rough estimates. In this section the estimates of total production are compared with EMR estimates of recoverable reserves for the QCI area. In the next section the number of exploratory wells in other Canadian offshore areas are compared with this paper's estimate of total exploratory wells for the QCI area.

In a recent paper by Proctor et al*, estimates of Canadian West Coast offshore hydrocarbon recoverable reserves were derived. In Tables 3 and 4 these estimates are compared with the estimates of potential production derived in this paper. The tables suggest that the U.S.-based estimates derived in this paper for oil potential are an order of magnitude higher than those derived by EMR. On the other hand the estimates of gas potential are about the same order of magnitude.

In a personal communication with Procter it was learned that the estimates in the 1983 paper are out of date and too low; it is conceivable that the 1983 estimates of recoverable reserves could be understating more recent estimates by as much as a factor of 10. Gas reserve estimates also are expected to be higher. The reason is

*Procter, R.M., G.C. Taylor and J.A. Wade, Oil and Natural Gas Resources of Canada, Geological Survey of Canada, Paper 83-31, Ottawa, Ontario 1983.

Table 3

Two EMR Estimates of Total
Oil Production

	B bbl.	$10^6 m^3$
EMR-Oil Potential* for West Coast		
Average Expected	0.3	50
Speculative Estimates	0.7	110
Estimated Total Production** for QCI Area (Table 2)	1.94	309

Table 4

Three EMR Estimates of Total
Gas Production

	Tcf	$10^9 m^3$
EMR-Gas Potential* for West Coast		
High Confidence	1.3	36.8
Average Expected	9.45	268.0
Speculative Estimates	26.6	753.0
Estimated Total Production** for QCI Area (Table 2)	5.43	153.8

*Recoverable reserves
**Derived from U.S. estimates

that when 14 exploratory wells were drilled by Shell between 1967-69, the theory of plate tectonics had not yet been accepted and therefore was not used. The wells penetrated only relatively immature sediments and were not deep enough to enter any oil generation windows. The origin of oil and gas-prone sedimentary basins is now much better understood so that present resource estimates for the offshore Queen Charlotte area are considerably greater than those originally developed by EMR*.

It is therefore considered that U.S.-based estimates of total oil production, although higher than the original conservative estimates of EMR by an order of magnitude, are nevertheless reasonable approximations.

Thus, on a proportionate basis with production in the U.S. offshore areas, 274 exploratory and delineation wells, 37 production platforms and 1,022 production wells can reasonably be expected in the QCI area, provided that hydrocarbons are discovered.

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*Based on presentations by a) C. Yorath, on the geological history and petroleum potential of the QCI area, Victoria, 1982; and b) G.C. Taylor, on the petroleum potential of offshore B.C., Victoria, 1983.

4. A Comparison With Present Offshore Exploratory Activity

For an alternative appreciation of the relative magnitude of the numbers derived in this paper, Table 5 provides figures on exploratory wells already drilled in other parts of Canada, even though the geology of those areas may different from that of the west coast.

Table 5

Number of Exploratory Wells To Date
in Various Offshore Regions of Canada

	Number of Exploratory Wells
Beaufort	46
Grand Banks & Labrador Sea	100
Nova Scotia Offshore	100
Queen Charlottes	14

While these numbers are not as great as the projected 274 exploratory wells for the QCI area, they are of the same order of magnitude. Moreover, exploration is far from complete in all of those areas.

Another perspective can be gained through comparison of the estimates to the 293 exploratory wells drilled in the California OCS since 1963 with the 274 well estimate that is derived in this paper for the QCI area.

In summary, the scenario developed in this paper for the QCI area is a reasonable preliminary estimate of the level of activity that could result if economically viable hydrocarbon reserves are discovered.

5. Conclusions

In this paper estimates of potential offshore activity in the QCI area have been derived and compared. Estimates have been developed to provide a basis for determining the resulting potential for environmental impacts. The estimates of level of activity were based on:

- U.S. west coast offshore oil figures,

and were compared to:

- EMR estimates of Canadian west coast reserves, and
- Present offshore exploratory activity in Canada and the U.S.

It is concluded that if projected California and Alaska offshore hydrocarbon activity proves to be a reasonable basis for estimating Canadian West Coast Offshore potential then some 274 exploratory and delineation wells could be drilled over the life of the QCI hydrocarbon resource area. This in turn could lead to an estimated 1,022 development and production wells and 37 production platforms.

15. Glossary of Terms

Hydrocarbons - Any of a number of organic compounds, often referred to as "fossil fuels", such as natural gas and crude oil.

Exploration* - A phase of offshore hydrocarbon development, lasting from 1 to 8 years, which extends from the granting of the lease (q.v.) to the time when commercially recoverable hydrocarbon reserves are located.

Delineation* - A phase in offshore development during which further drilling is carried out to determine the size and extent of the reserves discovered during exploratory drilling.

Development* - Lasting from 4 to 20 years, this phase involves activities required to bring a field to the point of commercial production. This is the most intense period of activity, and may include the construction of production platforms, pipelines, terminals, and processing plants.

Production* - This phase may last from 5 to 25 years. Wells are brought into operation and the hydrocarbons are transported to shore for storage, refining, or marketing.

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*The above sequences in hydrocarbon development are not mutually exclusive and may therefore overlap.

Barrel - A measurement of volume, usually for oil, equal to 35 Imperial gallons. There are about 6.28 barrels (bbl) in one cubic meter.

Cubic Foot - A measurement of volume, usually for natural gas. There are about 35.3 cubic feet (cu. ft. or cf) in one cubic meter.

Hectare - A measurement of area, equal to 10,000 square meters, or about 2.47 acres. Abbreviation "ha".

Structure-Year - The number of years a stationary offshore structure, such as an exploratory rig or a production platform, remains at a particular site. For example, 5 rigs drilling in a given area over a period of 3 years would represent 5x3=15 structure-years.

Lease - A permit issued by the government, subject to a number of terms and conditions, allowing a proponent to explore for and/or develop hydrocarbons in a given area.

Tertiary Sediments - Sediments deposited during the Tertiary Period, between 63 million and 1 million years ago.

Scenario - For the purposes of this report, a hypothetical event or sequence of events and consequences extrapolated from a base of empirical data.

Conditional Mean - In referring to estimates of hydrocarbon activity, the average total amounts of gas or oil expected to be produced on the condition that recoverable reserves of hydrocarbons are discovered.

Variance - The mean of the squares of the variations from the mean of a frequency distribution.

Plate Tectonics - A theory of continental drift, according to which the earth's crust moves on individual plates of mantle which form at an ocean ridge and sink back into the mantle at a deep-sea trench.